SUPERCRITICAL COAL-FIRED POWER GENERATION COOPERATIVE EFFORT BETWEEN BABCOCK & WILCOX AND THERMAL POWER RESEARCH INSTITUTE OF CHINA

Jim Zhou & Haolin Mi

ABSTRACT

Babcock & Wilcox USA (herein B&W) and Thermal Power Research Institute, State Power Cooperation of China (herein TPRI) has established a technical cooperation for many years. Under this frame, a considerable number of cooperative projects achieved a great success. Both sides are satisfied with the mutual and fruitful cooperation and benefits.

B&W is a world-class company supplying steam generators with state-of-art technologies. TPRI is the leading Research Institute for the Chinese Utility Industry with an abundance of practical experiences in China. The cooperation between B&W and TPRI is established on a mutually exclusive and beneficial basis to supply each other's technological needs. This kind of mutuality might be considered as a good example of a successful cooperation between a developed and developing APEC member.

The past fruitful relationship drives both sides to extend their areas of cooperation to supercritical (SC) power generation. The details of the cooperation on SC technologies have been undertaken but are not yet finalized.

The cooperation on SC technologies will be beneficial to the development of SC technology in China, which is a hot spot in China. Public opinion and experts believe that the SC power generation firing fossil fuels will be predominant to meet the power demand in China for the next several decades.

1 PREFACE

1.1 Cooperation Partner Introduction

B&W

Since 1867, Babcock & Wilcox USA (herein B&W) has been serving the changing needs of the utility and industrial areas and their steam requirements for power generation and technical processes. B&W is the leading global supplier for fossil utility boilers, and engineers and manufactures of the world's largest utility boilers (1300 MW). Today, with more than 270,000 MW of installed capacity in 85 economies, B&W is truly powering the world.

These boilers include both our mature designs and our latest engineering achievements:

- Radiant drum boilers;
- Once-through boilers including the conventional UP with constant pressure furnace and spiral variable furnace design and the new advanced SC boiler with vertical internally ribbed tube variable pressure furnace;
- Process recovery boilers, including the compact Modular Recovery boiler;
- Nuclear steam generators;
- CFB & Stirling power boilers;
- Environmental protection products including Wet/Dry FGD scrubbers and SCR /NSCR.

Today's power generation products require advanced engineering and manufacturing capability. To meet this demand, B&W owns extensive design and manufacturing resources with the latest technologies and systems. Our research center is the largest in the world compared to other boiler manufactures, which helps to maintain B&W's position as a technical leader.

Through innovative energy solutions and total-scope services, B&W is dedicated to ***powering the world*** in an environmentally safe, efficient and economical manner.

TPRI

Chinese Thermal Power Research Institute (herein TPRI) is a research organization directly subordinated to the State Power Cooperation (SP – the former Ministry of Electric Power in China). Its major research and development activities are devoted to thermal power generation technologies and equipment. TPRI has been playing the role of a scientific and technical center in the field of thermal power generation in China since 1951.

Main fields of research and development at TPRI:

- Thermal power generation equipment, control systems and their auxiliaries;
- New thermal power generation process and equipment;
- Power plant emission control technologies and equipment;
- Clean coal power generation technologies (CFBC, IGCC, PFBC, ABGC, FC);
- Conventional island of nuclear power plant;
- New energy resources for power generation (Geothermal Power, Wind power, Solar);
- Other related technologies.

Activities of TPRI towards thermal power plants and manufactures are including research and development, design and manufacture, commissioning and operation adjustment, performance evaluation and analysis, consultations, training and technical transfer, etc. TPRI acts as the quality inspection center of thermal power generation equipment and materials of SP, the Quality Inspection Center of Power Generation Fuels of SP, the Center of Chemical Cleaning for Power Generation Equipment of SP, the Technical Training Center of Thermal Power Generation, the National Engineering Research Center of Clean Coal Combustion.

TPRI has been involved in much international technical cooperation including government-related and private firm-related projects.

The previous government-related projects, which have been executed and finished, included the China-Germany Thermal power technology cooperation project; the China-Canada clean coal technology cooperation project; and China–US IGCC technology cooperation project. Recently on April 20, 2000, USA/DOE and PRC/MOST (Ministry of Science & Technology) had signed a protocol on the fossil fuel technology cooperation. TPRI has been selected as playing a leading role within the Annex 1—Power System under the US-China Protocol.

TPRI also has collaborated with many foreign private sectors such as B&W-USA; MBEL-UK and CE-USA, etc.

1.2 Superiority and Mutualization of Cooperative Partners

- **B&W**

B&W is a leading supplier of steam generators in the world with almost 140 years' history. B&W owns extensive design and manufacturing resources with the latest technology systems.

B&W Research and Development Center conducts continuous research programs in all aspects of fossil power development, nuclear steam systems, material development and evaluation, and environmental and manufacturing technologies.

In addition to identifying new and innovative technologies, and applying them to our new products, except to conduct research and testing programs within the US, B&W also cooperates with foreign firms to carry R&D programs.

These R&D programs keep pace with the diversification of energy sources and the demand for high-quality, more economical power plants.

- **TPRI**

TPRI is the biggest research institute in China within the utility side. Their links with utility authorities and power plants are unique in China.

TPRI is an institute that emphasizes the practical applications, which is different from most academic type research organizations. Their researchers have rich experiences from sites. Their engineers are knowledgeable to run tests at sites. Their in-house facilities are advanced in China.

Under the US-China FE Technology Cooperation Protocol, TPRI has been selected as the key Chinese member of the Permanent Coordinate Group of the Power System--the Annex 1 of the Protocol.

2 BRIEF REVIEW OF PAST COOPERATION

The following is a brief review of the past major cooperative events of B&W and TPRI**.**

2.1 Burner Upgrading Project

Shijiazheng Power Plant in China has installed 2X350 MW B&W-made downshot boilers firing blended semi-anthracite coal in early 1990. The original burners installed were the B&W first generation DRB type burners firing less than 14 % VMdaf blended semi-anthracite. In order to improve the fuel flexibility to allow these units burning less volatile anthracite, the existing burners were upgraded by B&W's newly developed XCL-PAX burner.

TRPI's test team with B&W representatives jointly did combustion system and pulverizing system adjustments and balancing the air and coal flow to the burners as well as balancing to aerodynamic in the furnaces.

After the work is finished, these units can burn 100% YQ anthracite, which is 8% VMdaf, with a very good flame stability. The minimum load without oil support can achieve 50 % burning 100% YQ anthracite. The fuel flexibility of these units is greatly improved. This was a very good feature for power plants before Chinese coal market deregulation.

2.2 The Behavior of NOx Emission by Firing Chinese Coals

In order to understand the formation and emission of Nox firing Chinese from utility boilers, TPRI and B&W have conducted tests at utility boilers with either Wall-firing or Tangential-firing to understand the mechanism of Nox formation and emission firing Chinese lean coals. The tests reveal the impact of the combustion air splits and excess air to burner air zones on the NOx formation. The results were used to verify the NOx prediction for engineering designs.

2.3 Xibapo PP Combustion System Tunning

Xibapo Power Plant has 4x300 MW lean coal-fired units supplied by BWBC, which is a B&W Subordinate Company in China. These units have adopted the indirect bin firing combustion system, which is different from the direct combustion system that B&W has adopted. The pulverizing system was designed by the Chinese local design institute, and they still preferred to apply the bin system, which produces the vent air due to pulverizing. The vent air arrangement to furnace must cooperate with burners to avoid the negative impact on the ignition. To improve the flame stability at low load, the TPRI test team did a fine tuning on the combustion and pulverizing systems. The flame stability then was improved.

2.4 Coal Characteristics

B&W also entrusted TPRI with conducting the ordinary coal analysis for various Chinese projects. B&W also entrusted TPRI to run in-house tests at their facility (TGA, DTGA and column furnace to learn more details of the coal characteristics such as the index of ignition; index of burnout, slagging and fouling behavior, etc). These works not only helped B&W to better understand the Chinese coal properties for their design, but also improve TPRI understanding and accumulating their coal data base.

2.5 Exchange Technical Information, Visitation and Bridging

There are several ways between B&W and TPRI to exchange their technical information. TPRI had paid visitations to B&W and our research center many times. We also paid return visitations to TPRI and visited their test facilities. Such communications between B&W and TPRI maintain at least once per year.

Both sides also utilize the links of each side in their own economies to bridge to extend contacts with more organizations. It greatly widens B&W and TPRI links in this area for better cooperation.

2.6 Joint Seminar or Workshop

B&W with TPRI had held a seminar trip in China to promote the internal separation CFB technology in China in 1998. The seminar trip included several presentations within 5 different Chinese cities. The attendees for the seminars were invited by TPRI. Since the presentations, TRRI continues to help B&W maintain contact with these potential customers.

3 POSSIBLE AREAS FOR EXTENDING COOPERATION

3.1 Low NOx Combustion Technologies

Low NOx combustion technologies now are being sought by Chinese utility. The Nox regulation mandated by the Chinese Environmental Protection Agency has started to execute. All new units larger than 300 MW are required to install low Nox combustion devices. The low NOx burner plus OFA for two-stage combustion technology seems to be the first choice to reduce the Nox emission.

Chinese Nox regulation has only one limit, 650 mg/m3, for all types of coals. Chinese power plants burn a lot of low volatile coals and anthracite. The Nox levels are greatly above the regulation limit. Therefore there is still room for cooperation on de-Nox study.

In the near future, the cooperation of de-Nox on the post-combustion might be considered. B&W have advanced SCR and NSCR de-Nox technology.

3.2 CFB (Circulating Fluidized Boiler)

Since 1985 the development of CFB technology in China has become hot and fast. Chinese local research had developed various types of CFB type boilers. So far none of these types obtained a substantial success, especially such types with an internal impact separation technology. So domestic-developed CFB still did not scale up for utility application.

TPRI has a 1 MW CFB test facility and an impact separation device. They had conducted tests on the separation efficiency of the vertical U-beam separator. B&W has a mutual internal U-beam separation CFB technology. Cooperation might extend to this area. It also jointly offers technologies for 100MW PC units repowering.

3.3 Condition Assessment

The condition assessment technology for major power plant equipment is being gradually accepted by the Chinese Utility Industry to replace the traditional scheduled maintenance. B&W had several dialogues with TPRI on the topic and will continue on it.

3.4 Chinese Coal Characteristics

B&W with TPRI had cooperated on the combustion area for low volatile coal ignition characteristics as well as the Nox emission behavior. The further work might be moved to the area of the impact of coal and ash properties on the heat transfer in furnace.

3.5 Clean and High Efficiency Coal Power Generation Technologies

This area could include the supercritical PC firing power generation technology, which currently is under ongoing cooperation, which will be discussing details.

Besides, it also could include renovation for existing units on efficiency improvement such as combustion system fine-tuning, mill upgrading.

4 THE BASIS OF ONGOING COOPERATION ON SC TECHNOLOGY

4.1 The Background of Chinese Utility Development

- **Past Fast Growth**

Within the past almost two decades, Chinese Utility Industry had a very rapid development. The following chart shows the development. These statistics/data are picked up from published documents by State Power Cooperation (SPC).

Year	1980	1987	1995	2000
Capacity				
Total Installed GW	65.87	102.897	217.224	300.0**
Annual Growth %	--	5.29	13.89	9.42
Annual Installed MW	--	5290	14291	16555
Fossil Fuel Fraction %	69.15	70.66	75.98	NA
Electricity				
Generated TWh	300.6	497.3	1006.9	1230*
Fossil Fuel Fraction %	80.64	79.85	81.45	81.54*

Note: * : to the end of 1999
****: to middle of April, 2000**

From the chart, it is clear that the fossil fuel generation capacity remains above 70%, while the electricity generated by fossil fuel exceeds 80%.

- **Slow Down**

The growth slowed down and had fallen to bottom a few years ago, before the year 2000. The actual reasons are complex. From the outside, South-East Asia economic crisis might have affected Chinese manufacture for exporting. The Chinese marketing mechanism change could be an internal reason. The electric grid development is much behind the growth of the generating capacity, which limits final users to receive sufficient supply. The large amount of small diesel generating units run by small private enterprises are not controlled by grids, but share the load demand.

Large capacity units of the utility industry during that period only had typically 50 % load demand of the unit nominated rate for most of a day.

- **Recovery**

Currently the statistics data shows that the national economy recovers from recession. The following charts released by SPC indicate the fast re-growth is returning.

Electricity Generated (Jan. - June, 2000 6 month statistics)

	Amount TWh	***Increasing %(VS. 1-6, 1999)***	***Percentages in total %***
Total	628.4	+ 9.9	100
By fossil	**521.4**	**+ 7.7**	**82.97**
By hydro	98.2	+ 23.0	15.53
By nuclear	8.2	+ 15.0	1.30
Balance	0.6	-	0.20

Electricity Consumption (same period)

	Amount TWh	***Increasing % (VS. 1-6, 1999)***	***Percentages in total %***
Total	626.9	+ 10.70	100.00
Primary industry	25.2	+ 5.10	4.02
Secondary industry	460.0	+ 10.70	73.38
Thirdly industry	67.5	+ 11.90	10.76
Residential	74.2	+ 11.80	11.84

The newest statistics data indicates the fast growth continues in July 2000:

	Amount TWh Increase. % (VS. July 1999)	***Increase. % (VS. 1-6 average)***	
Total	119.37	13.46	14.25
Fossil	95.493	16.45	9.9
Hydro	22.153	2.08	35.35
Nuclear	1.67	15.58	22.19

4.2 10th Five Years Plan (FOP) & Forecasted Growth

When the 9th FOP was planned, the target of the utility development was:

- The total installed capacity achieved 290 GW in end of year 1999 and achieved 300 GW in April, 2000. The 9th FYP target had been achieved.
- Total new installed capacity reached 80 GW in five years, and 16000 MW per year. It was also achieved as planned.
- The electricity generated in year 2000 reached 1400 TWh with an average 7% increasing rate. The first half year of 2000, it reached 628.4 TWh; in July of 2000 the monthly electricity production was 119.37 TWh. Therefore, the target is most likely to be achieved.

The targets of 10th FYP, which is just set, include:

- Capacity increment will be 70 GW with 4.0-4.5 % growth rate.
- Removing or repowering 30 GW capacity in total of old small-medium capacity PC units to achieve clean and high efficient power generation.

As the medium term plan of next FYP, Chinese Utility is seeking:

- Total installed capacity reaches 500-550 GW.
- Fossil fuel fraction still exceeds 70%. Hydro achieves 115 GW, Nuclear 20 GW, New energy 2.5 GW.

4.3 Forecast of Chinese Utility Development for Next 50 Years

The following chart shows the forecast:

Year	2000	2010	2020	2050
Electricity TWh	1400	2500	3200	7000-8000
Capacity GW				
Total	300	540	800	1500-1800
Fossil	77.8%	75.3%	71.6%	~66.7%
Hydro	21.0%	20.0%	21.5%	~15.5%
Nuclear	0.09%	3.8%	5.1%	~12.2%
Renewable	0.3%	0.9%	1.8%	~5.9%

The above forecasts are picked up from PRC-US Experts Report on Integrated Gasification Combined-Cycle Technology, Dec. 1996. From this old report, we still can find that up to 2050, the fossil fuel power generation will be still dominant.

4.4 Peculiarities of Chinese Utility Industry

The Chinese Utility Industry made great progress during the past two decades. Its capacity and yearly electricity production are both ranked as second positions in the world.

The Chinese Utility Industry has its own peculiarities to determine its further development**.** The most important points are summarized as follows:

- **Low per capita**

The per capita of the installed generating capacity/electricity is only 0.23 KW/1077 KWh (based on the 2000 data and 1.3 billion population), respectively. It is considerably low compared to the developed economies. On other hand, it indicates that there is still much room for further development.

- **Highly dependent on coal firing for power generation**

From its developmental history and present developmental plan, it is very clear that coal is a major energy source for power generation and will remain so for a long time in the forecasted future. More than 70% of PC generating capacity has already been maintained for the past 50 years. Based on the energy resource institute in China, the amount of 70% will still be kept for a long time. Referring to the US with rich natural gas resources, the coal firing for power generation is still around 48%. The period from 70% down to 50% for China will last considerably longer until new energy sources become available.

- **Low energy utilization efficiency**

The Chinese Utility Industry uses a "Standard Coal Consumption Rate", i.e. several hundred grams of "standard coal "are burned to generate one Kilo-Watt-hour electricity, as an index for energy utilization efficiency. Standard Coal is defined as having 7000 Kcal/Kg LHV (12600 BTU/lb).

The following chart shows the coal rate from 1985-2000.

Year	85	87	89	90	92	94	95	96	97	98	99	00
Net	431	432	432	427	420	414	412	410	408*	--	396	391**
Gross	398	397	397	392	386	381	379	377	--	--	368	--

All data except * and ** are from Chinese Government " 97 Energy Report of China"
* from 99 Energy Saving Report, Chinese Energy Research Association
** released by State Power Cooperation

The rate reduction is mainly gained by adding more new large high-efficiency units and removing/ replacing old smaller low-efficiency units; or gained by optimization of operation and fine tuning of boiler combustion, etc.

The average rate of 2000 (Jan.-June) in China is 391, while the advanced leading fuel rate in the world is around 317 g/KWh at present. The Chinese rate is still 19% higher. It was expected to be reduced down to 345 g/KWh.

The possible and available technologies should be the super/ultra-supercritical power generation technologies for new installing units, and CFB or other advanced power generation technologies for repowering/renovation of the old low-efficiency units. For details, two attached papers could be referred.

- **High Pollution**

Due to being greatly dependent on coal firing, the environmental pollution by power generation is very severe. The mandated environmental regulations have not been established for too long and are not fully executed due to various reasons. The total generating capacity with De-SOx devices per 9th FYP should reach 10-12 GW in year 2000, which is only 3%-4% of total generating capacity. Only few newly installed large units are equipped with low NOx burners.

The CO2 emission currently is ranked second in the world. In 1997, a total of 822 Mt carbon was emitted into the air by fossil fuel utilization in China.

The Utility Industry consumes almost 25-30 % of total national coal production every year. It is the biggest CO2 polluter. Based on the 1400 TWh, electricity will be generated for the year 2000, and 80% by coal firing, if we are assuming the coal rate is 391 g/KWh and the carbon content of coal is 70 %, the Chinese Utility Industry will emit 306 million tone carbon into air in year 2000.

The available De-SOx technologies in the market are various for selection. Wet scrubber is not popular due to its cost and space requirements. The CFB boiler is quite favorable by repowering of small-medium capacity units. E-beam & activation carbon methods as well as the CFB scrubber technologies are being undertaken for development. The applications of those technologies are depended individual cases.

The De-NOx is just starting. The upper limitation of NOx by utility firing fossil fuel is 650 mg/NM3 regardless of the coal type. Most units have no De-NOx facility and on-line monitoring capability. There is no post-combustion De-NOx facility such as SCR or SNCR. Only several mordent large new units have low NOx burners.

- **Air Toxic and PM2.5**

Some Chinese Academic organizations have started early exploration studies. The Utility Industry has not gone so far.

- **GHG**

The topic of GHG has become quite hot in China. The climate change has pushed human society to address the issue. Chinese Authorities and the Utility Industry gradually understood its importance and Chinese responsibility due to the large amount of CO2 emission from China. They are more aggressively participating in carbon sequestration activities in the world.

At the current stage, the Chinese Utility Industry mainly adopts the efficiency improvement for CO2 reduction while Research Institute and Universities in China have started some preliminary studies to develop various sequestration technologies.

4.5 Possible Technologies to Face the Challenges

Based on the facts of a 70%+ power generation by coal firing, in order to meet the continuous growth demand while satisfying environmental requirements, the Chinese Utility Industry most likely will emphasize the high energy conversion technologies for both new and existing units.

- **New Installed Capacity**

The large capacity super/ultra-supercritical PC power generation is their first choice.

- **Existing Capacity**

Repowering or removing/replacing the existing 100-200 MW & below units by CFB units is their way to go. Several projects are being undertaken.

The combustion system fine-tuning and equipment upgrading plus operation improvement are also helpful.

5 THE AREAS ON SC TECHNOLOGY PROPOSED BE COOPERATED

The following four areas for cooperation on SC technology, which are interested in by both sides, have been discussed through TPRI and B&W a long time ago. Some area or a part of the area has already been conducted.

Since TPRI plays a key role within the permanent coordinate members on the Chinese side for the Annex 1- Power System under US-China Fossil Energy Technology Cooperation Protocol, the following four areas have been proposed as the one of the cooperation tasks to the US side under the protocol.

5.1 Materials

- **Long-Term Creep Properties**

From thermodynamics, above the supercritical point increasing the steam temperature is the most effective way to boost efficiency for a Rankine power generation cycle. As literature reports, each 20C steam temperature increase will boost 1% on the plant efficiency for a single reheat unit and 2% for a double reheat unit.

The benefits on efficiency by steam temperature increasing are greatly dependent on the long-term creep strength of the metals of boiler pressure parts. The Ferritic steel has enabled steam temperature to be increased above 566C. The low-alloy steel T22 can be used up to 580C with adequate creep strength. For higher steam temperature with corrosion concern, the Austenitic steel will be considered. Materials with improved creep properties such as P91/T91/F91 enable steam temperature to be increased to 600C. The material area in China is very weak. Therefore it is an important area for cooperation.

- **Weldability**

The weldability of a high creep strength metal is an important factor to impact for the development of the high creep strength alloy. Usually such alloys require more complex welding technologies and heat treatment after being welded. The site welding conditions are normally poor, and create a problem for erection of the boiler.

- **Corrosion**

There is a tendency that with the application of higher steam temperature on the metal exposed to fire, the metal surface corrosion becomes severe. The development of the oxidation of the metal internal surface in waterside is speeded up. Therefore the new high alloy for better creep strength also should have a good anti-corrosion feature.

5.2 Hydraulic Properties of Advanced Vertical Tube Furnace

The hydraulic characteristics of an advanced vertical tube for a once-through type boiler are still underway for R&D. The first generation of a once-through boiler with a vertical tube membrane furnace due to its hydraulic properties is not good for operation under subcritical conditions and for

sliding pressure operation. The Chinese have learned experience from their subcritical vertical tube once-through boiler design and its operation. The unbalanced heat flux by furnace geometry and dynamic fluctuation of operation often cause the departure from nucleate boiling (DNB) and results in frequent tube failures, even though the design had already adopted a very small ID tube (22/11 mm OD/ID) and very high mass flow rate (1800 kg/m2sec).

Siemens, who works with B&W and others, has developed an advanced vertical internal-ribbed tube membrane furnace design. It has been tested at Farge PP in Germany. B&W is undertaking more extensive tube tests at Allegheny PP, in Pennsylvania, USA. Chinese and US sides prefer more detailed tests.

5.3 Variable Pressure Operation

Variable pressure operation (sliding pressure operation) is desired in many modern power plants because it provides more efficient part load operation. The loss due to constant pressure operation at low load is always a concern for the utility. The B&W UP style vertical tube supercritical boiler can provide variable turbine pressure operation to gain the thermodynamic advantage of variable pressure. Since the boiler furnace must be operated in the supercritical region, this is accomplished by a pressure-reducing valve located between superheater stages. Thus the turbine efficiency advantages are obtained but without the savings in boiler feed pump power associated with true variable pressure operation. The spiral tube furnace design can be operated in the subcritical region thus also providing the pump power savings. The advanced SC boiler with vertical internally ribbed tube furnace design may also be operated in the subcritical region and thus provides the same pump power savings in variable pressure operation plus the advantage of a lower full load pressure loss for additional power savings.

5.4 Chinese Coal Characteristics

The engineering design of a boiler firing Chinese coals by foreign venders is normally based on the venders' experiences firing their local coals, which have a similar composition of the major coal and ash components. However, it is found it could cause some operation problems firing Chinese coals due to lack of understanding on Chinese coal combustion and emission characteristics.

Due to the deregulation of the Chinese coal market, the coal being supplied to power plants varies. Power plants now allow shifting their daily burning coals from designed to cheapest coal from the market to lower the operation cost. Designers need to learn more on coal properties to increase the boiler tolerance on fuel.

TPRI assesses a large Chinese coal database and making it available to partners for use.

6 CONCLUSIONS

- The mutual cooperation between B&W/USA and TPRI/PRC has been established for a long time. Based on the superiority of the cooperative partners, a considerable amount of cooperative projects have been completed. The successful cooperation has created benefits for each other.
- The development of the Chinese Utility Industry has had a great influence on the cooperation. The cooperative areas and level, the project amounts, and the applications and promotions of the results from cooperative projects are most likely dependent on the development of the Chinese Utility Industry.
- The supercritical coal-fired power generation technology is a clean and high efficiency fossil fuel utilization technology. Based on Chinese energy resources and its energy policy, it will be dominant and main fleet of the Chinese Utility Industry for at least the next 50 years to meet the continuous growing power demand. Currently the Chinese Utility Industry has recovered and started fast growth again.
- B&W and TPRI have reviewed the forecast of the development of Chinese Utility, and both decided to shift the existing cooperation areas to cover and dedicate the area of supercritical coal-fired power generation.
- The cooperation on supercritical coal-fired power generation technology covers everything from the materials to hydraulic-operation and fuels.
- This cooperation will coordinate with the activities under the US-China FE Technology Cooperation Protocol.